Space Weather Technical Forecast

Issued on Saturday, 04 May 2024 at 12:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Further M-flares expected with a chance of isolated X-flares through the period. G1/G2 (Kp5-6) conditions are likely in the coming days with a chance of G3 (Kp7) intervals.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is at High levels, due to an M9.1 flare at 04/0619 UTC from AR3663 in the north-centre disc, which has also produced a number of other M-class flares during the period. Region AR3664 in the southeast has also been active. An M1.2 flare was also observed from Ex-AR3654 over the southwest limb at 03/2247 UTC. There are currently nine sunspot regions on the visible disc. Of these AR3663 and AR3664 are the largest and most complex, both containing delta spots with continued growth. AR3666, approaching centre-disc, developed rapidly, with a moderately large lead spot and less well defined trailer region. The remaining sunspot groups are much smaller and appear more magnetically simple.

There are potentially two Earth-directed CMEs during the period. A CME that left the Sun around 01/0600 UTC from the southwest disc, resulting from a large filament eruption, is expected to hit Earth late day 1 (04 May) or early day 2 (05 May). Additionally, a CME associated with the X1.6 flare at 03/0222 UTC has been analysed and may interact with Earth in the middle of day 2 (05 May).

A filament eruption starting around 03/2000 UTC near the unnumbered sunspot region to the east of AR3666 in the northeast disc resulted in a fairly wide coronal dimming and associated EUV wave in coronagraph imagery. Indications are a CME has resulted given there was an associated Type II Radio Emission, however a temporary delay in LASCO and STEREO A imagery availability means that there is a slight delay in assessing the event. The M9.1 flare from 06/0619 UTC was also associated with a Type II Radio Emission, with slight coronal dimming observed. This event will also be analysed once imagery becomes available.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 steadily declined from slightly elevated levels to near background levels, currently around 360-380km/s. Density was below average to average, with a peak of 9 ppcc at 04/0648 UTC. The Interplanetary Magnetic Field, Bt, was at weak levels throughout. The north-south component, Bz, varied weakly. Phi angle was negative (towards the Sun) at first. but then became predominantly positive (away from the Sun) from 03/1830 UTC. Resultant Geomagnetic activity was Quiet (Kp0-2).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) observed at GOES18 was at normal background levels. High energy electron flux (greater than 2MeV) observed at GOES16 remained at background levels. The associated 24-hour fluence was well below the Active threshold. Observed fluence at 04/0001UTC was 1.08e6 integrated pfu on a steady trend.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High solar activity is forecast to continue with further M-flares expected and a chance of isolated X-flares, principally from AR3663 and AR3664.

Solar Wind / Geomagnetic Activity: Two Earth-directed CMEs currently feature in the forecast period. The first most likely arriving late on day 1 (04 May) or early day 2 (05 May) and the second expected at Earth midday 2 (05 May). Two other potential CMEs that left the sun late 03 May and early 04 May are awaiting analysis.

Initial slow-ambient solar winds are expected to increase on day 1 (04 May) due to the influence of CH33/+. Speeds should become slightly elevated to elevated between days 1 and 3 (04-06 May). A second HSS from CH35/+ is expected on days 3 and 4 (06 and 07 May), with speeds likely peaking at elevated to strong levels before starting to decline on day 4 (07 May).
Combining effects from the various CMEs and HSS influences through the period results in a lower than average Geomagnetic forecast confidence.

Geomagnetic activity although initially Quiet, is expected to increase on day 1 (05 May), becoming Active to G1/Minor Storm by the end of the day with a chance of G2/Moderate to G3/Strong Storm conditions. Conditions will most likely average out at G1/Minor to G2/Moderate Storm levels on day 2 (06 May) with a chance of isolated G3/Strong Geomagnetic Storm intervals. Activity should generally subside into day 3 (06 May), though should predominantly remain between Unsettled and G1/Minor Storm levels, again with a chance of isolated G3/Strong Geomagnetic Storm intervals. By day 4 (07 May), Quiet to Unsettled conditions are most likely, but still with a chance of G1/Minor Storm conditions persisting for a time and also dependent on the analysis of the anticipated CME from late 03 May.

Energetic Particles / Solar Radiation: High energy proton flux is most likely to remain at background levels through the period. There is a slight chance for an S1/Minor Storm or greater event occurring days 1 and 2 (04 and 05 May), increasing to a chance days 3 and 4 (06 and 07 May), should any proton-rich flares occur, primarily from AR3663.

High energy electron flux is forecast to be at background to moderate levels throughout, with associated fluence expected to remain well below the Active (1e8 integrated pfu) threshold.

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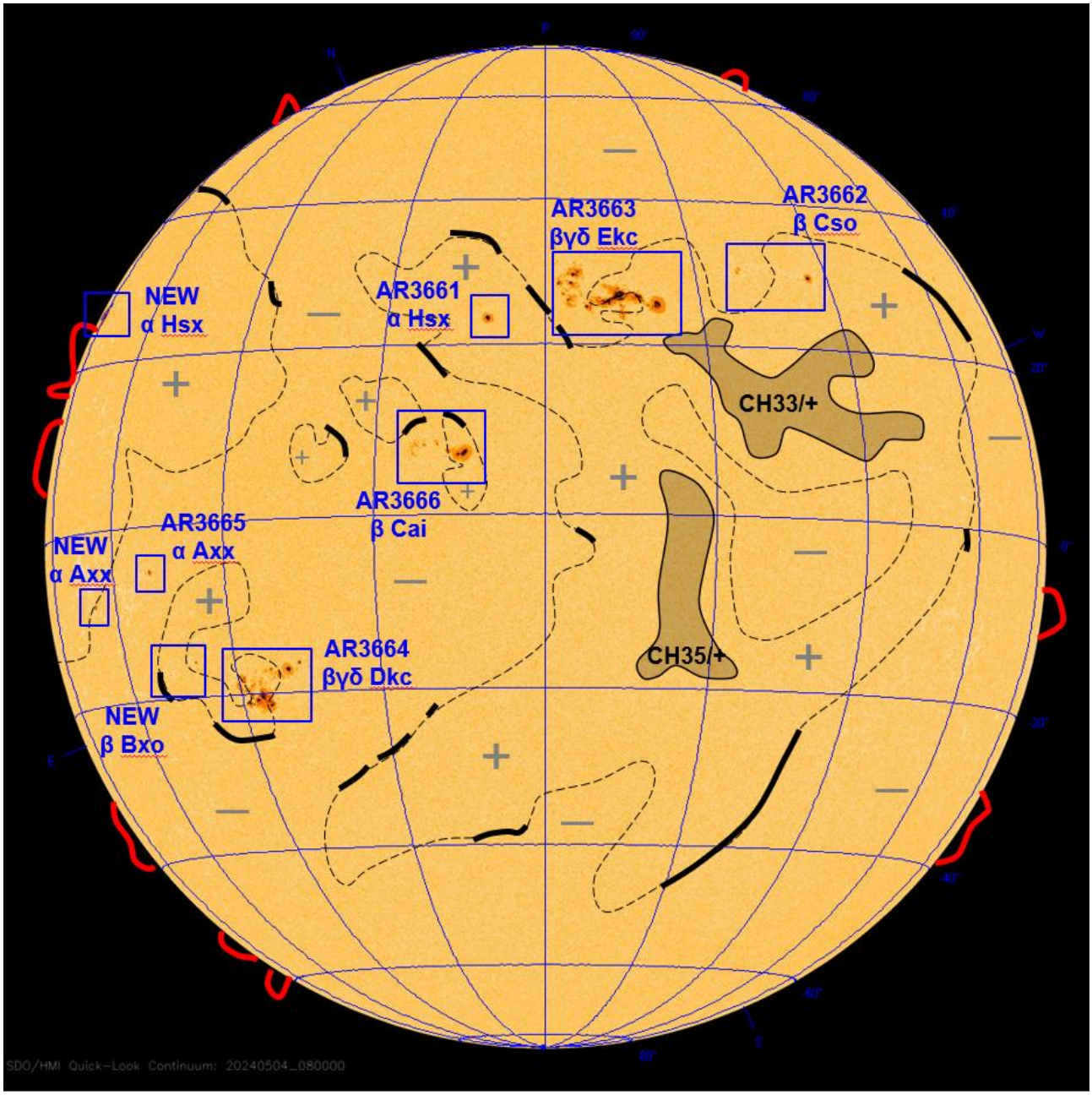
Figure 1. Solar Analysis Valid 04/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
Two Earth-directed CMEs currently feature in the forecast period. A CME that left the Sun around 01/0600 UTC from the southwest disc, resulting from a large filament eruption, is expected to hit Earth late day 1 (04 May) or early day 2 (05 May). Additionally, an Earth directed CME associated with the X1.6 flare 03/0222 UTC, should interact with Earth towards the middle of day 2 (05 May). Both features carry greater than average uncertainty with respect to timings and magnitude of effects, given limited imagery when analysing them.

A filament eruption starting around 03/2000 UTC near the unnumbered sunspot region to the east of AR3666 in the northeast disc resulted in a fairly wide coronal dimming and associated EUV wave in coronagraph imagery. Indications are a CME has resulted given there was an associated Type II Radio Emission, however a temporary delay in LASCO and STEREO A imagery availability means that there is a slight delay in assessing the event. A Type Ii Radio Emission was also observed from the M.1 flare on 04/0619 UTC, with some coronal dimming observed. Forthcoming coronagraph imagery will be looked at to determine any CME.

A HSS from CH33/+ is likely to increase solar wind speeds on day 1 (04 May) and may cause winds to become elevated and continue through day 2 (05 May), before subsiding through day 3 (06 May). Although CH33/+ is a persistent feature, it is larger and more defined on this rotation, making persistence forecasting challenging. Another HSS from CH35/+ is expected to become geo-effective later on day 3 (06 May). On the previous rotation ~460km/s peak speeds were observed. The coronal hole is noticeably larger than last time and could see speeds peak at elevated to strong levels between days 3 and 4 (06 and 07 May) before slowly declining on day 4 (07 May).

Combining effects from the various CMEs and HSS influences through the period results in a lower than average Geomagnetic forecast confidence.

Geomagnetic activity although initially Quiet, is expected to increase on day 1 (05 May), becoming Active to G1/Minor Storm by the end of the day with a chance of G2/Moderate to G3/Strong Storm conditions. Conditions will most likely average out at G1/Minor to G2/Moderate Storm levels on day 2 (06 May) with a chance of isolated G3/Strong Geomagnetic Storm intervals. Activity should generally subside into day 3 (06 May), though should predominantly remain between Unsettled and G1/Minor Storm levels, again with a chance of isolated G3/Strong Geomagnetic Storm intervals. By day 4 (07 May), Quiet to Unsettled conditions are most likely, but still with a chance of G1/Minor Storm conditions persisting for a time and also dependent on the analysis of the anticipated CME from late 03 May.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	80	90	70	30
Strong	G3	No	30	40	20	5
Severe	G4	No	5	10	5	1
Extreme	G5	No	1	1	1	1

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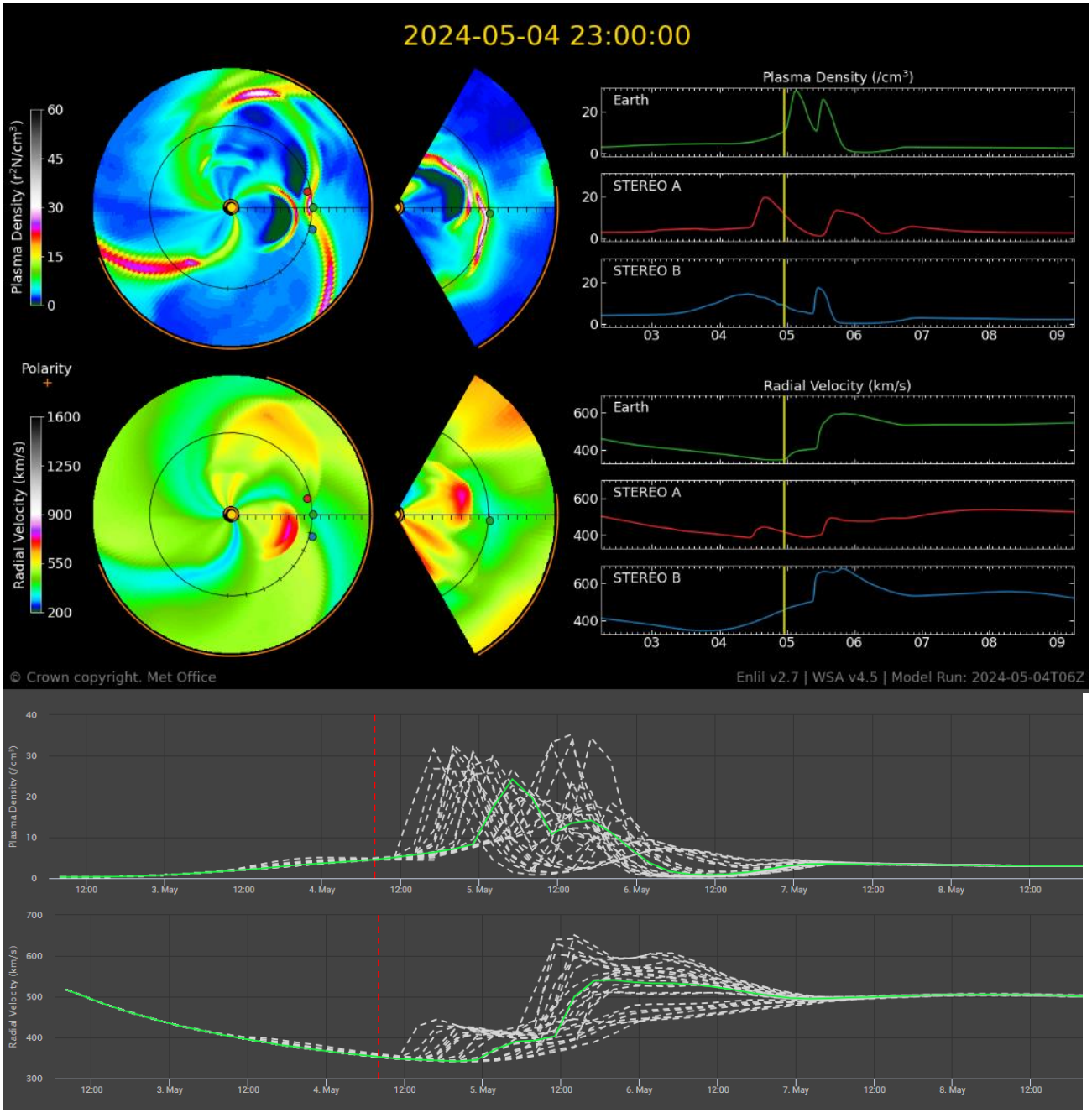
Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
01/1259	Partial	Filament	SW	585 km/s	04/2300 UTC	Nil.
03/0646	Partial	AR3663	NE	900 km/s	05/1000 UTC	Nil.

Figure 2: MOSWOC Enlil and Ensemble showing spread of arrival times of CMEs and HSS.



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Radio Blackouts - X-Ray Flares:

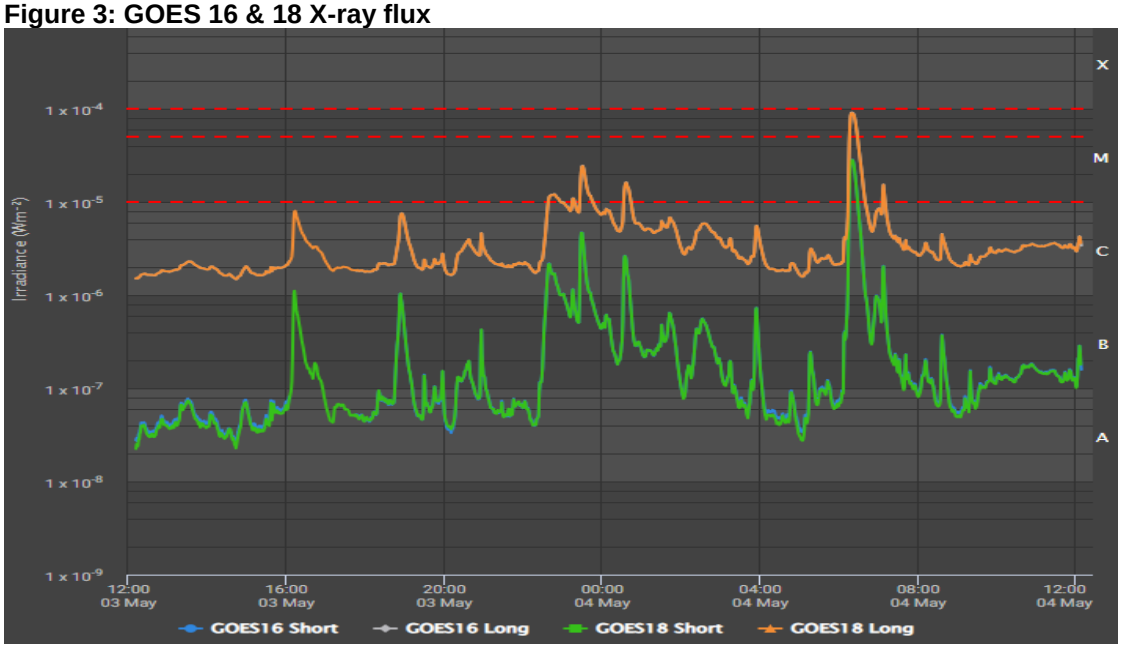
There are currently nine sunspot regions on the visible disc, six of which are numbered. The most active is AR3663 in the north-centre disc, which produced an X1.6 flare at 02/0222 UTC and an M9.1 flare at 04/0619 UTC. It features a large and complex delta spot within the intermediate portion of the group. The region continues to evolve with the emergence of a number of small intermediate spots with differential movement indicating significant magnetic shear and potential for further strong flares. AR3664 located in the southeast is the second largest spot on the disc and has produced two M-class flares in the past 48 hours, containing a small delta region in its southern intermediate spot. The region has slowly evolved with a recent increase in total spots and penumbral extent. AR3666, nearing centre-disc, has continued to develop, including the emergence of some small interior spots, although lacks a mature trailer spot and umbra at this time. The remaining sunspots on the disc are generally smaller and relatively stable magnetically.

Far-sided helioseismographs indicate a number of returning regions over the northeast horizon in the coming days that may supplement the present risk of significant flares should they persist.

Moderate to High solar activity is forecast to continue with further M-flares expected and a chance of isolated X-flares, principally from AR3663 and AR3664.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	25	25	25	25

Figure 3: GOES 16 & 18 X-ray flux



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Solar Radiation Storms - (High Energy Protons):
High energy proton flux (greater than 10MeV) observed at GOES-18 has been at background levels and is most likely to remain that way through the period. However, there is a slight chance of an S1/Minor Storm or greater event occurring days 1 and 2 (04 and 05 May), increasing to a chance on days 3 and 4 (06 and 07 May) should any large, proton-rich flares occur, primarily from AR3663 as it reaches a more geoeffective position in the coming days.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	15	15	20	20
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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High Energy Electrons Event (≥ 2MeV):
High energy electron flux is at normal background levels. Combined CME and coronal hole influences through the period are expected to limit electron flux at background to moderate levels on all days.

Overall, the 24 hour integrated electron fluence is forecast to remain well below the Active (1e8 integrated pfu) threshold.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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